

Simposium "Humanitarno razminiranje 2012."

Šibenik, 24 - 26 April 2012

An overview of GIS-based Multi-Criteria Analysis of priority selection in humanitarian demining

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Introduction

In Croatia, over the past ten years, a **priority setting using Multi-Criteria Analysis (MCA)** coupled with **Geographic Information System (GIS)** has been deployed in mine-action management.

A multi-criteria approach gives an opportunity for stakeholders to express their needs and requirements through a set of criteria.

Why was it necessary to use the MCA?



The main reason:

Evaluate areas contaminated with mines, which demining will have the **biggest positive influence** on refugees' return, revitalization of economic and social life, having, at the same time, less possible costs and more possible safety.

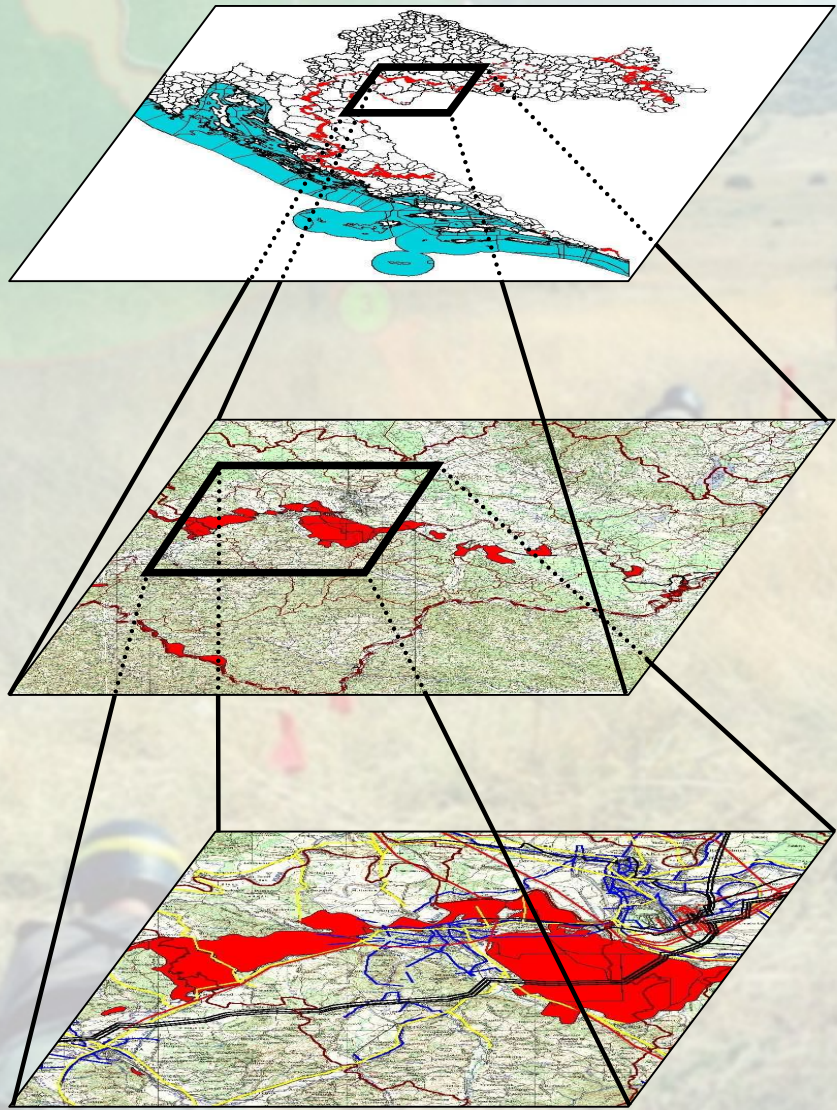


Hence, the problem was complex due to the following characteristics:

- **High demining price**
- **Conflict of interests**
- **Hierarchic nature of the problem** (several solution levels)

*In practice, **conflicts among human demining objectives occur very often**, and it usually happens that objectives from external interests are in conflict with objectives generated within the system.*

***The conflicts are transferred to the criteria.** This inconsistency of the criteria creates the need for **the implementation of multi-criteria** analysis, because "classical" methods, including intuitive decision making, cannot evaluate compromised (optimal) solution for the humanitarian demining problems.*



Strategic level

- state level

Tactical level

- county level

Operative level

- municipality level
- particular demining projects

Summary

selected municipality will be analyzed below

selected municipality

selected economic

Impact of terrain

Economic impact of

Social welfare imp

Impact of land use



The application of MCA tools to the decision making process has been widely recognized for its utility in offering fundamental help for the decision maker in the presence of possibly conflicting targets.

In Croatia, two projects were managed using the MCA:

- 1. The County Plan of Demining Priorities for Sisako-Moslavacka County on the Basis of Multicriterial Analysis**
- 2. Risk Management in Mine-Contaminated Water Resources**

Some reviews of projects that used MCA:

Report on the GICHD Mission to Validate the Pilot County Mine Action Plan for Croatia (2002):

"...MCA is, in principle, quite suitable for decentralised application. However, the regional MACs and county authorities should be supported by dedicated staff in CROMAC headquarters. For the next round of CMAPs at least, additional support from an MCA expert such as Mr. Mladineo would also be required.

..UNDP and donor agencies should give strong consideration to providing support. Ideally, the Croatian-international partnership would involve institutions such as the Survey Action Center and/or the GICHD to ensure dissemination of findings and subsequent replication in other landmine affected countries."

Task Assessment & Planning (TAP) Cambodia Proposed Project Framework (2004)



“Decision support tools have been applied to the field of mine action on three occasions. The first project, completed by the Survey Action Centre (SAC), involved using Landmine Impact Survey data to compute Community Impact Scores.

*The two other projects, both of which were completed in Croatia, were the preparation of the Canton Mine Action Plan and the Croatia Waters Mine Action Plan. **The two Croatia projects were significantly more sophisticated in their use of decision support tools, and adopted a multi criteria analysis approach to support decision making.**”*

Why the application of MCA did not come to life generally?

One of the reasons is the lack of popular software support for MCA and "retention" of using MCA only in academic circles.

By developing "**GIS-based MCA Web Application**", main intention was **to bridge this "gap"** and to develop an user friendly interface acceptable for different "types" of stakeholders (donors, politicians and professional DM).

Sometimes the **different stakeholders are geographically dislocated**, but developed application is providing the priority setting process via Internet.

Consequently, **priority setting has become fully transparent** since stakeholders and donors are able to actively **join decision making process** using on-line web application.

Next slides show an example of:

Priority setting in Glina municipality of Sisacko-moslavacka County

Weights of criteria groups could be easily changed on-line with automatic update of MCA results.

The results of Multicriteria Analysis (MCA) are displayed in multiple ways: on a chart that represents PROMETHEE II output on a map by placing a rank number on each suspected minefield, and on a suspected minefield's **"map tip" with details about each suspected minefield's rank.**

Sisacko-moslavacka County – an overview with **sattelite map**



 GIS-based Multi-Criteria Analysis of priority selection in humanitarian demining

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Explore Map



Explore



Navigate



Maps



Tools



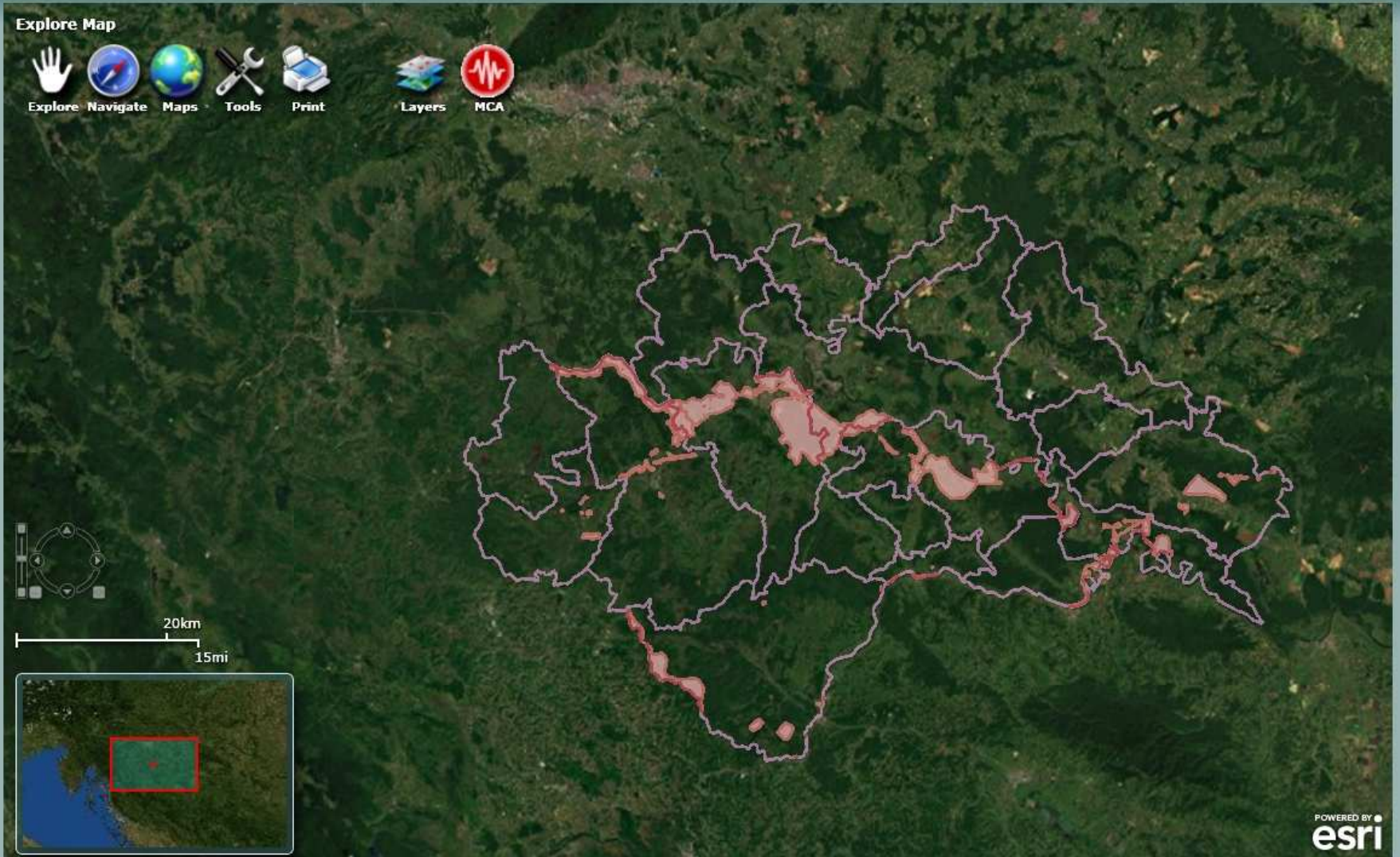
Print



Layers



MCA



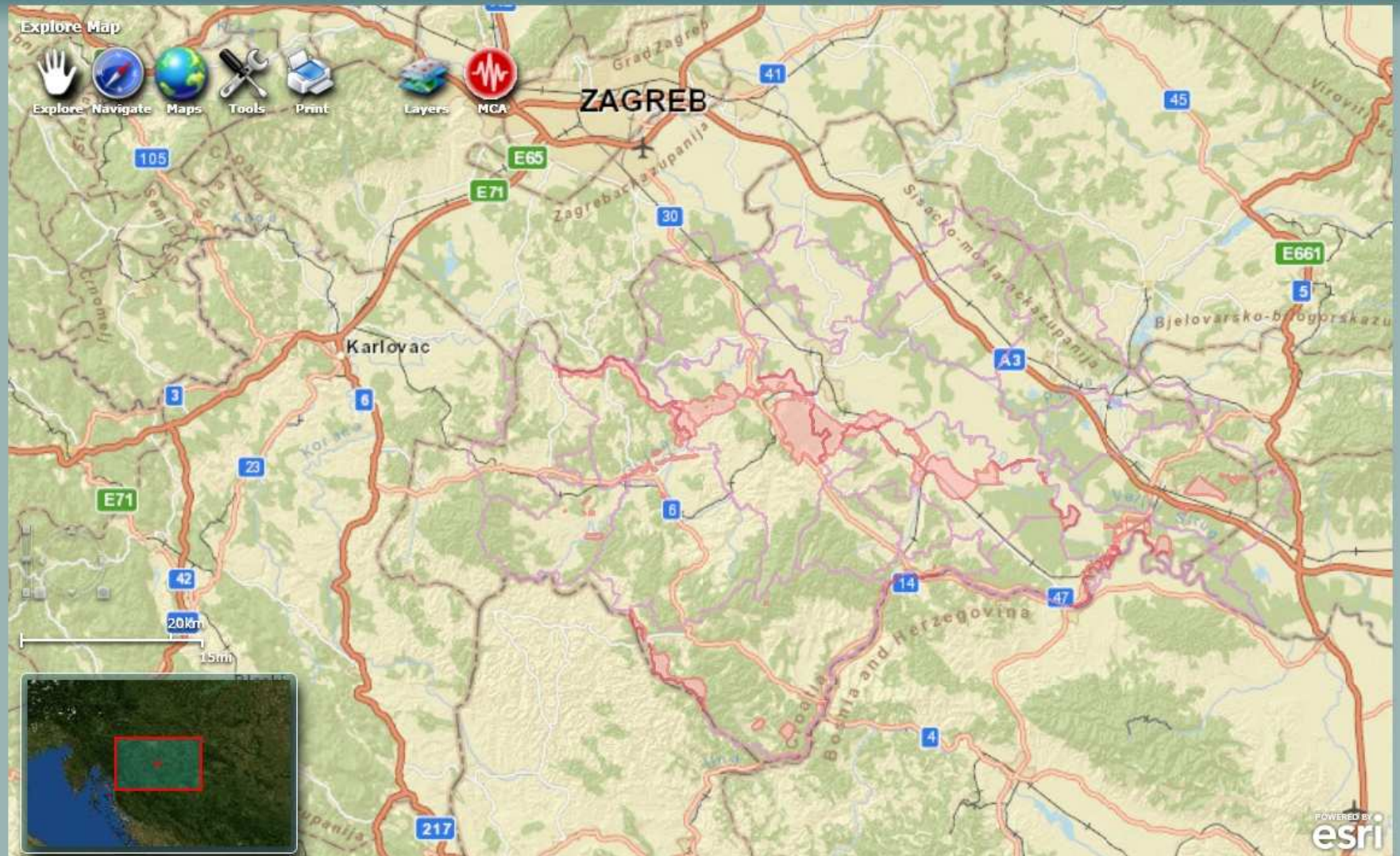
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Sisacko-moslavacka County – an overview with road map

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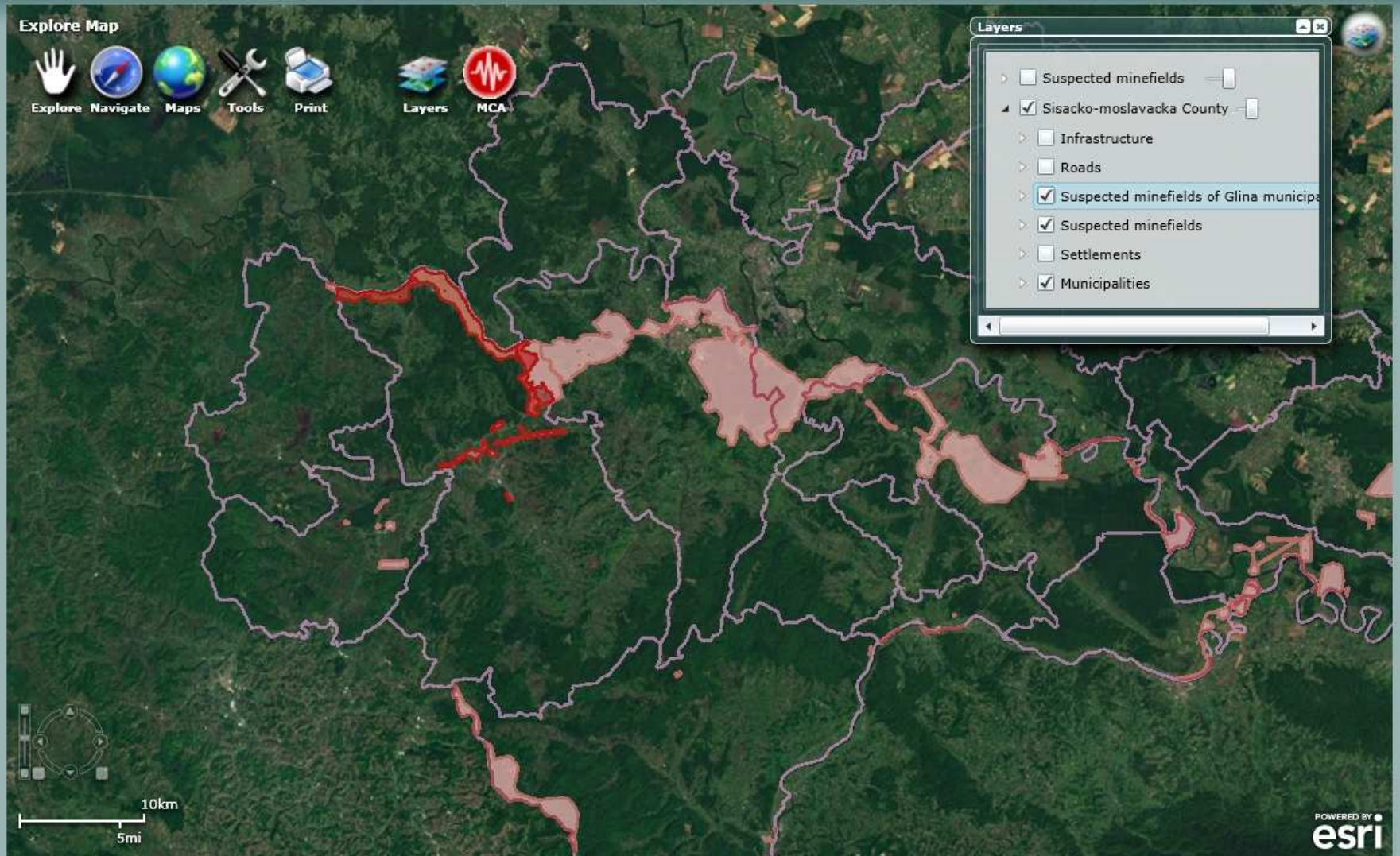


Sisacko-moslavacka County – an overview of suspected minefields

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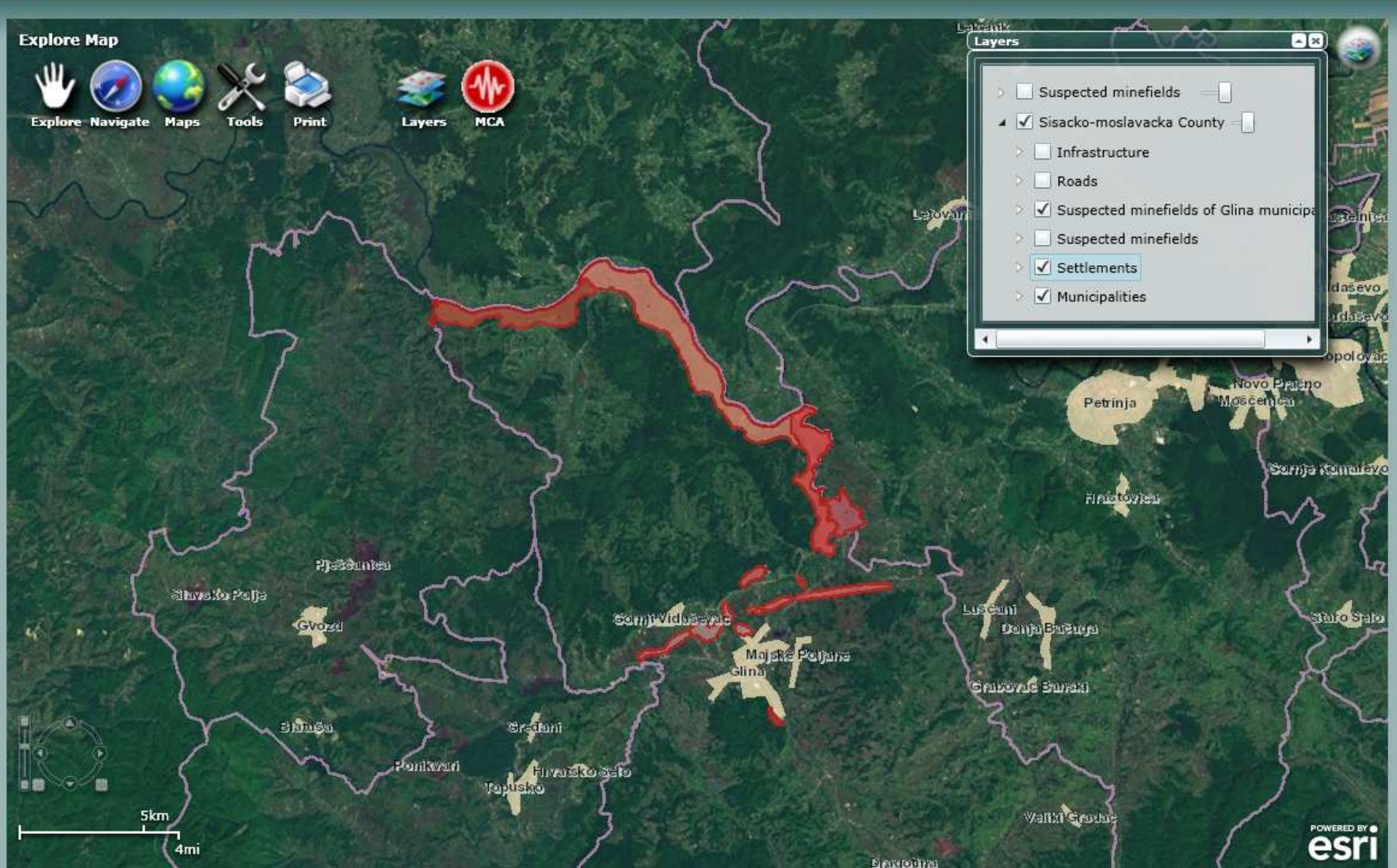


Glina municipality – an overview of suspected minefields and settlements

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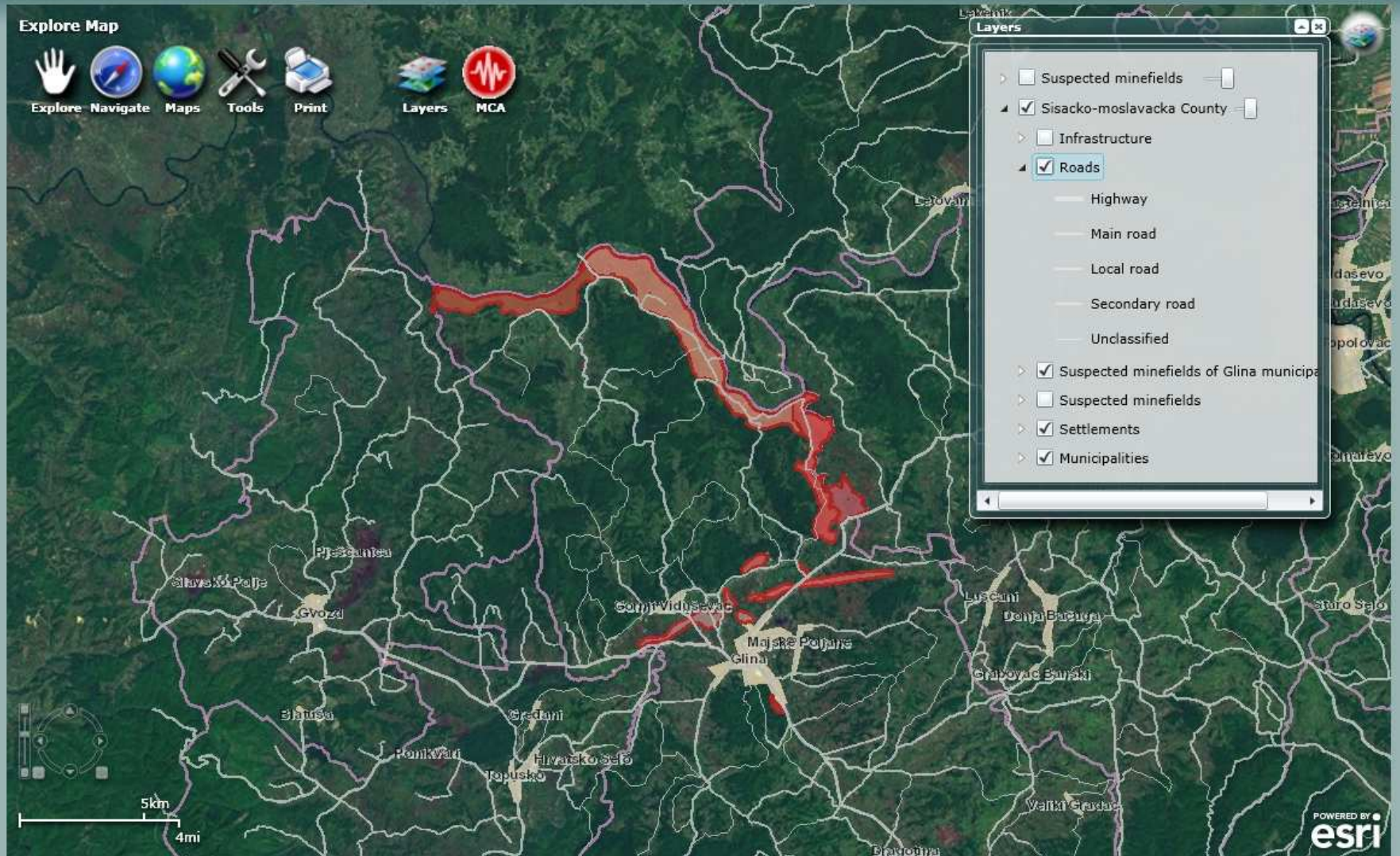


Glina municipality – an overview of suspected minefields and roads

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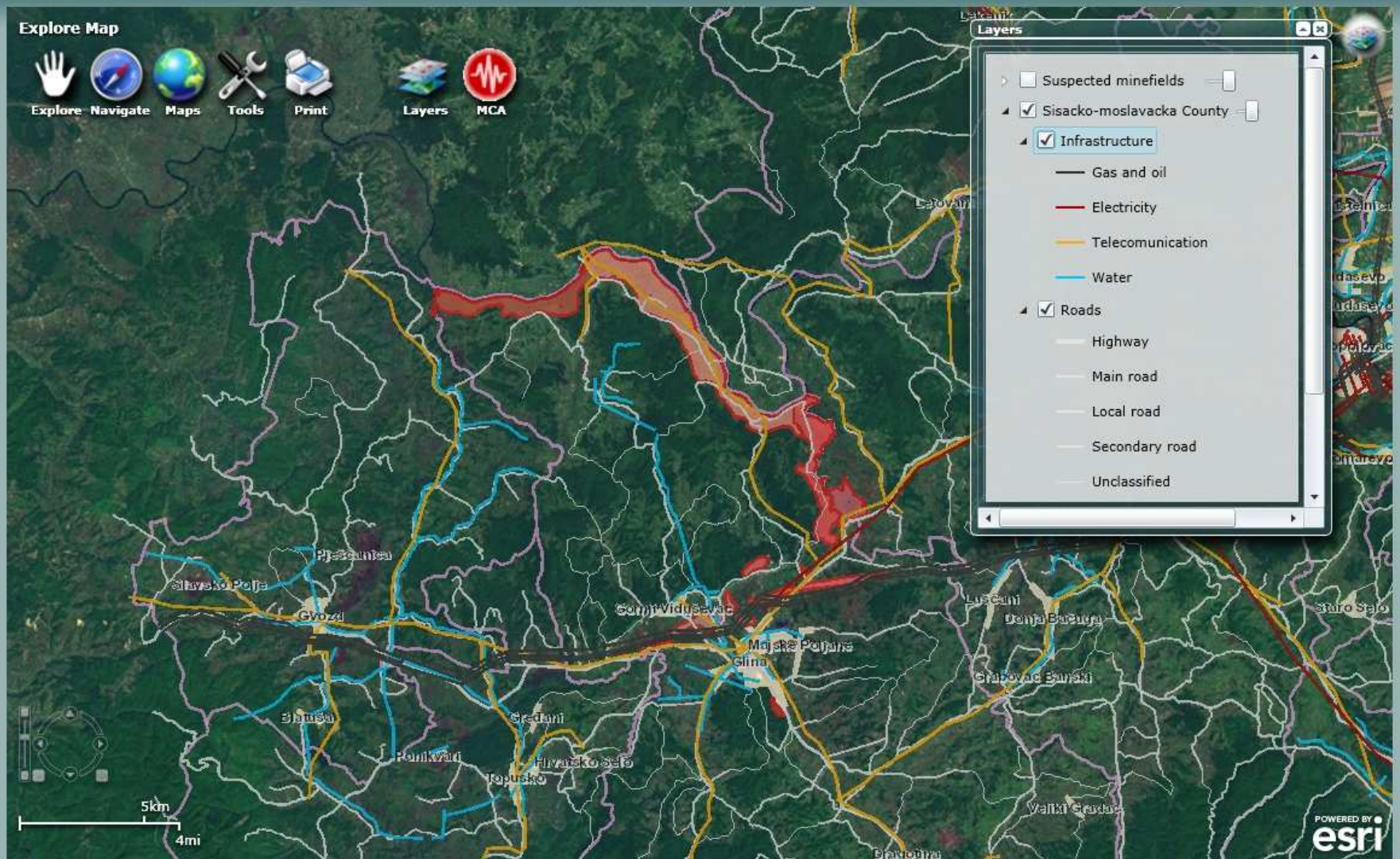


Glina municipality – an overview of suspected minefields and infrastructure

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Glina municipality – Multi-Criteria Analysis (MCA) tool



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The screenshot displays the MCA tool interface. On the left, the 'Explore Map' section includes icons for Explore, Navigate, Maps, Tools, Print, Layers, and MCA. The main map shows the Glina municipality highlighted in red, with various village names labeled. A dialog box titled 'MCA - Multicriteria analysis' is open, containing the following text:

Multicriteria analysis

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality:

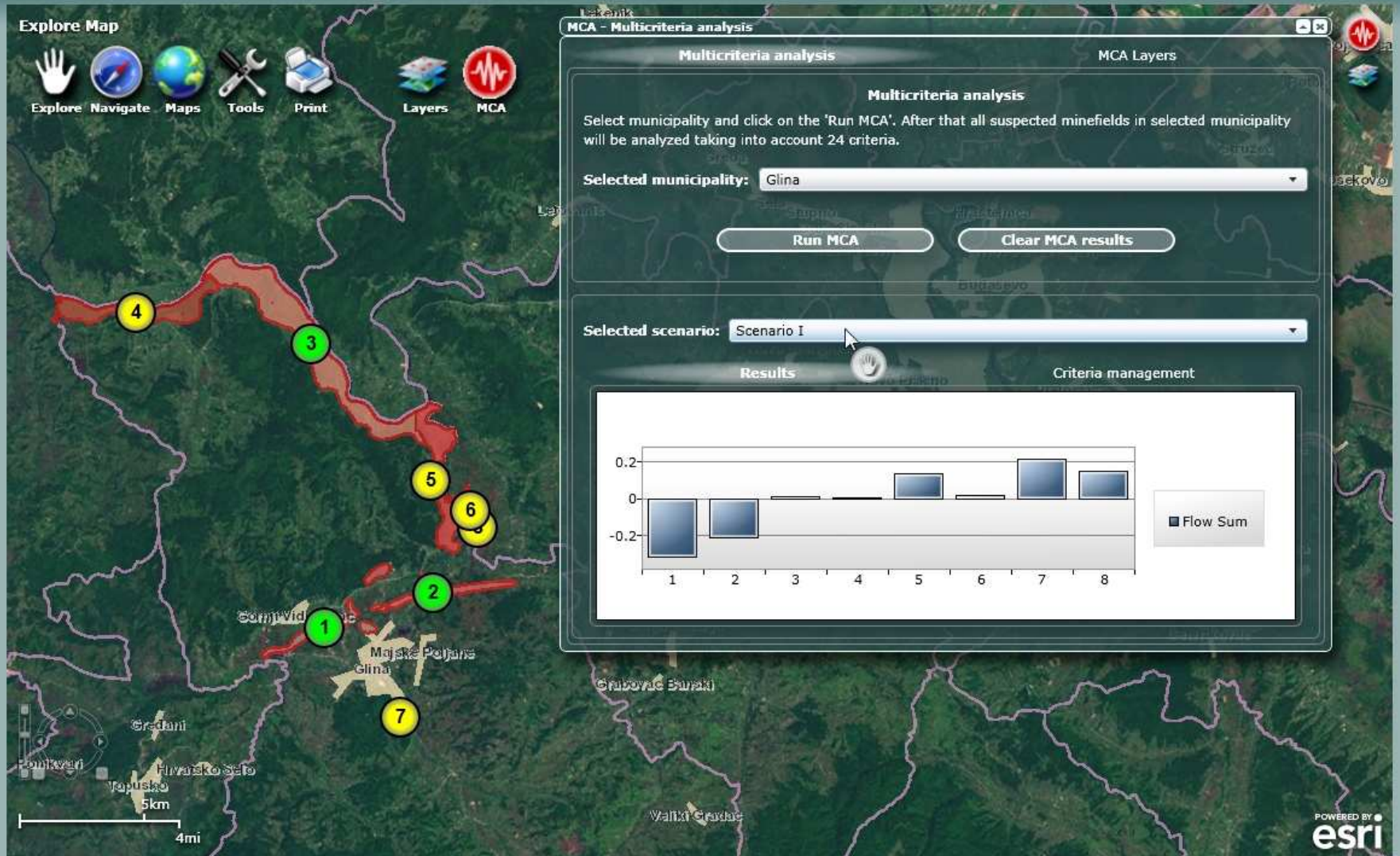
The map also features a scale bar (5km, 4mi) and a north arrow. The Esri logo is visible in the bottom right corner.

Glina municipality – results (ranking) of Multi-Criteria Analysis (MCA)

GIS-based Multi-Criteria Analysis of priority selection in humanitarian demining

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Glina municipality – "map tip" with details about suspected minefield's rank

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Explore Map
Explore Navigate Maps Tools Print Layers MCA

MCA - Multicriteria analysis

Multicriteria analysis MCA Layers

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA **Clear MCA results**

Selected scenario: Scenario I

Results **Criteria management**

Criteria	Flow Sum
1	-0.15
2	-0.15
3	0.05
4	0.05
5	-0.1
6	0.05
7	0.15
8	0.1

B10 Glina


Total rank:

★ Rank: **1**

Points: **100%**

5km
4mi

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The background image is a composite. It features a field with several people, some of whom appear to be in military or tactical gear, engaged in an activity. Overlaid on the top left is a map with a green circle and a red line. On the right side, there is a vertical panel with text and a pie chart at the bottom right. The text in the panel includes 'Manufacture', 'selected municipality', 'selected economic', 'Impact of terrain', 'Economic impact of', 'Social welfare impo', and 'Impact of land-m'. The pie chart is divided into four colored segments: red, yellow, blue, and green.

In order to alleviate the change of weight, the **criteria that could be concerned are assembled in four basic groups**, as follows:

- **Terrain characteristics and infrastructure,**
- **Economic impact of mine clearance,**
- **Social welfare,**
- **Land-mine risk reduction.**

Glina municipality – MCA criteria management tool

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Explore Map

Explore Navigate Maps Tools Print Layers MCA

MCA - Multicriteria analysis

Multicriteria analysis MCA Layers

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA Clear MCA results

Selected scenario: Scenario I

Results Criteria management

Criteria	Rating
Impact of terrain characteristics and infrastructure	★★★★★
Economic impact of mine clearance	★★★★☆
Social welfare impact	★★★☆☆
Impact of land-mine risk reduction	★★★★☆

Legend:

- Impact of terrain characteristics and infrastructure
- Economic impact of mine clearance
- Social welfare impact
- Impact of land-mine risk reduction

5km 4mi

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By scenario selection a decision stakeholder attitude is transferred into MCA.

On next slide we will see a predefined "**Scenario I**", which has a greater weights of criteria groups "Social welfare" and "Economic impact of mine clearance".

After that "**Scenario III**" is used with different weights, and finally the "**Custom scenario**" is used, in which the greatest weight has criteria group "Land-mine risk reduction".

Change of criteria weights affected ranks.

Initially, 1st rank had suspected minefield "B10 Glina", but after change of scenario 1st rank has suspected minefield "B13 Glina". And the other ranks were also affected.

Glina municipality – MCA using predefined Scenario I

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Explore Map

Explore Navigate Maps Tools Print Layers MCA

MCA - Multicriteria analysis

Multicriteria analysis MCA Layers

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA Clear MCA results

Selected scenario: Scenario I

Scenario I
Scenario II
Scenario III
Custom scenario

Impact of terrain: ★★★★★

Economic impact of mine clearance: ★★★★★

Social welfare impact: ★★★★★

Impact of land-mine risk reduction: ★★★★★

Legend:

- Impact of terrain characteristics and infrastructure
- Economic impact of mine clearance
- Social welfare impact
- Impact of land-mine risk reduction

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Glina municipality – MCA using predefined Scenario III

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Explore Map
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MCA - Multicriteria analysis

Multicriteria analysis MCA Layers

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA Clear MCA results

Selected scenario: Scenario III

Results Criteria management

Criteria	Rating
Impact of terrain characteristics and infrastructure	★★★★★
Economic impact of mine clearance	★★☆☆☆
Social welfare impact	★★☆☆☆
Impact of land-mine risk reduction	★☆☆☆☆

Legend:

- Impact of terrain characteristics and infrastructure
- Economic impact of mine clearance
- Social welfare impact
- Impact of land-mine risk reduction

5km 4mi

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Glina municipality – MCA using custom scenario

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Explore Map

Explore Navigate Maps Tools Print Layers MCA

MCA - Multicriteria analysis

Multicriteria analysis MCA Layers

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA Clear MCA results

Selected scenario: Scenario III

Scenario I
Scenario II
Scenario III
Custom scenario

Impact of terrain characteristics and infrastructure

Economic impact of mine clearance

Social welfare impact

Impact of land-mine risk reduction

■ Impact of terrain characteristics and infrastructure
■ Economic impact of mine clearance
■ Social welfare impact
■ Impact of land-mine risk reduction

5km
4mi

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Glina municipality – MCA using custom scenario

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Explore Map

Explore Navigate Maps Tools Print Layers MCA

MCA - Multicriteria analysis

Multicriteria analysis MCA Layers

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA Clear MCA results

Selected scenario: Custom scenario

Criteria management

Criteria	Rating
Impact of terrain characteristics and infrastructure	★★★★★
Economic impact of mine clearance	★★★★★
Social welfare impact	★★★★★
Impact of land-mine risk reduction	★★★★★

Legend:

- Impact of terrain characteristics and infrastructure
- Economic impact of mine clearance
- Social welfare impact
- Impact of land-mine risk reduction

5km 4mi

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Glina municipality – MCA using custom scenario

Explore Map

Explore Navigate Maps Tools Print Layers MCA

B13 Glina

Total rank:
★ Rank: 1
Points: 100%

MCA - Multicriteria analysis

Multicriteria analysis

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA Clear MCA results

Selected scenario: Custom scenario

Results

Criteria	Rating
Impact of terrain characteristics and infrastructure	★★★★★
Economic impact of mine clearance	★★★★★
Social welfare impact	★★★★★
Impact of land-mine risk reduction	★★★★★

Criteria management

- Impact of terrain characteristics and infrastructure
- Economic impact of mine clearance
- Social welfare impact
- Impact of land-mine risk reduction

5km
4mi

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Glina municipality – MCA using custom scenario

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Explore Map

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MCA - Multicriteria analysis

Multicriteria analysis MCA Layers

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA Clear MCA results

Selected scenario: Custom scenario

Results **Criteria management**

Criteria	Rating
Impact of terrain characteristics and infrastructure	☆☆☆☆☆
Economic impact of mine clearance	★★★★★
Social welfare impact	★★★★★
Impact of land-mine risk reduction	★★★★☆

Legend:

- Impact of terrain characteristics and infrastructure
- Economic impact of mine clearance
- Social welfare impact
- Impact of land-mine risk reduction

5km 4mi

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Glina municipality – MCA using custom scenario

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Explore Map

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MCA - Multicriteria analysis

Multicriteria analysis MCA Layers

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA Clear MCA results

Selected scenario: Custom scenario

Results **Criteria management**

Criteria	Rating
Impact of terrain characteristics and infrastructure	☆☆☆☆☆
Economic impact of mine clearance	★★★★★
Social welfare impact	★★★★☆
Impact of land-mine risk reduction	☆☆☆☆☆

Legend:

- Impact of terrain characteristics and infrastructure
- Economic impact of mine clearance
- Social welfare impact
- Impact of land-mine risk reduction

5km 4mi

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Glina municipality – MCA using custom scenario

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Explore Map

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MCA - Multicriteria analysis

Multicriteria analysis MCA Layers

Select municipality and click on the 'Run MCA'. After that all suspected minefields in selected municipality will be analyzed taking into account 24 criteria.

Selected municipality: Glina

Run MCA Clear MCA results

Selected scenario: Custom scenario


Results **Criteria management**

Impact of terrain characteristics and infrastructure	☆☆☆☆☆
Economic impact of mine clearance	☆☆☆☆☆
Social welfare impact	☆☆☆☆☆
Impact of land-mine risk reduction	★★★★★

Legend:

- Impact of terrain characteristics and infrastructure
- Economic impact of mine clearance
- Social welfare impact
- Impact of land-mine risk reduction

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Web GIS support has all ordinary tools for **distance, area and radius measurement.**

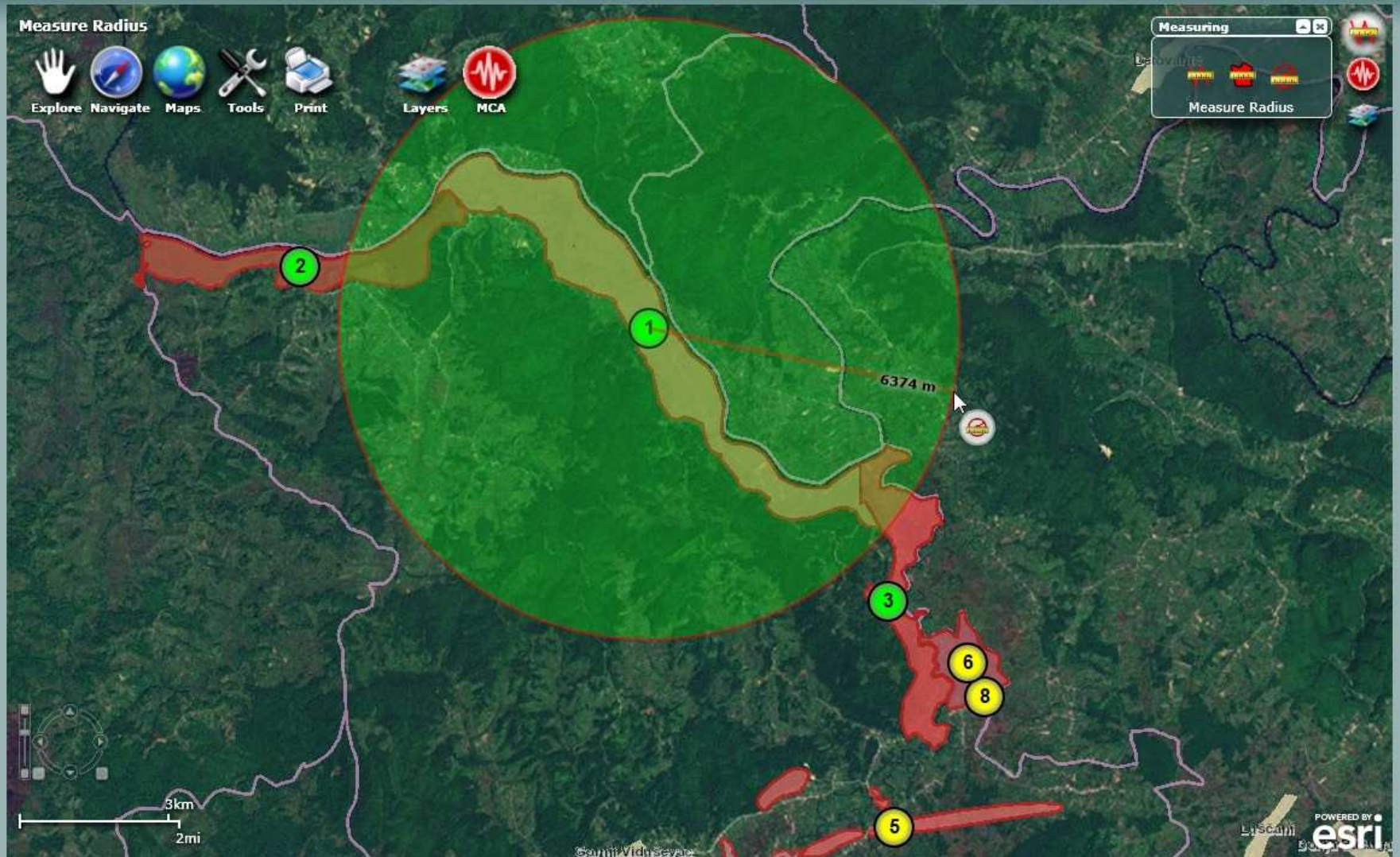
It also supports **custom drawings for own mark-ups and notes.**

Glina municipality – radius measurement

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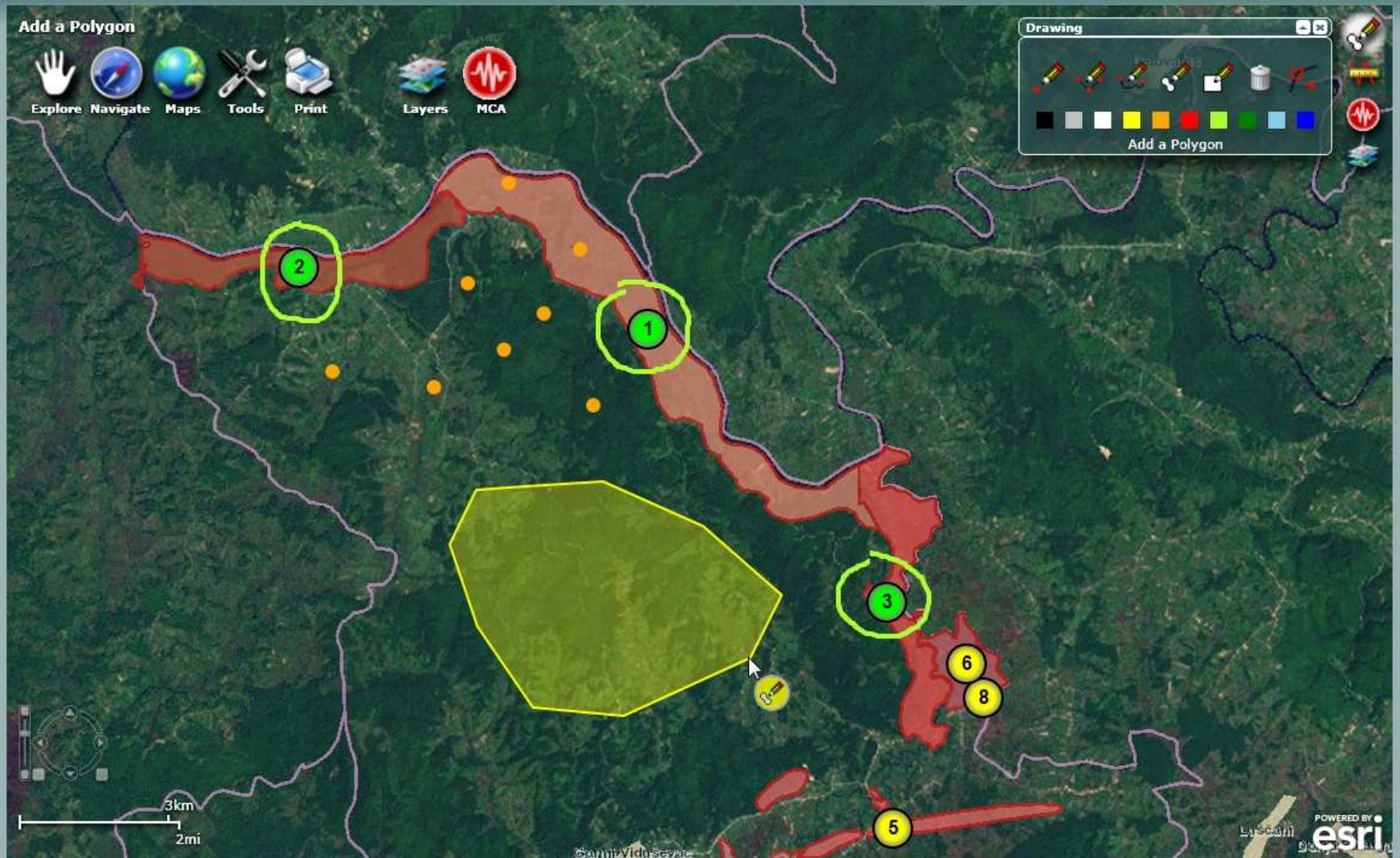


Glina municipality – drawing custom mark-ups and polygons

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**THANK YOU
ON YOUR ATTENTION !!!**

humanitarian

Select municipality and
will be analyzed taking

Selected municipality

Selected scenario:

Impact of terrain

Economic impact of

Social welfare imp

Impact of land-mi

